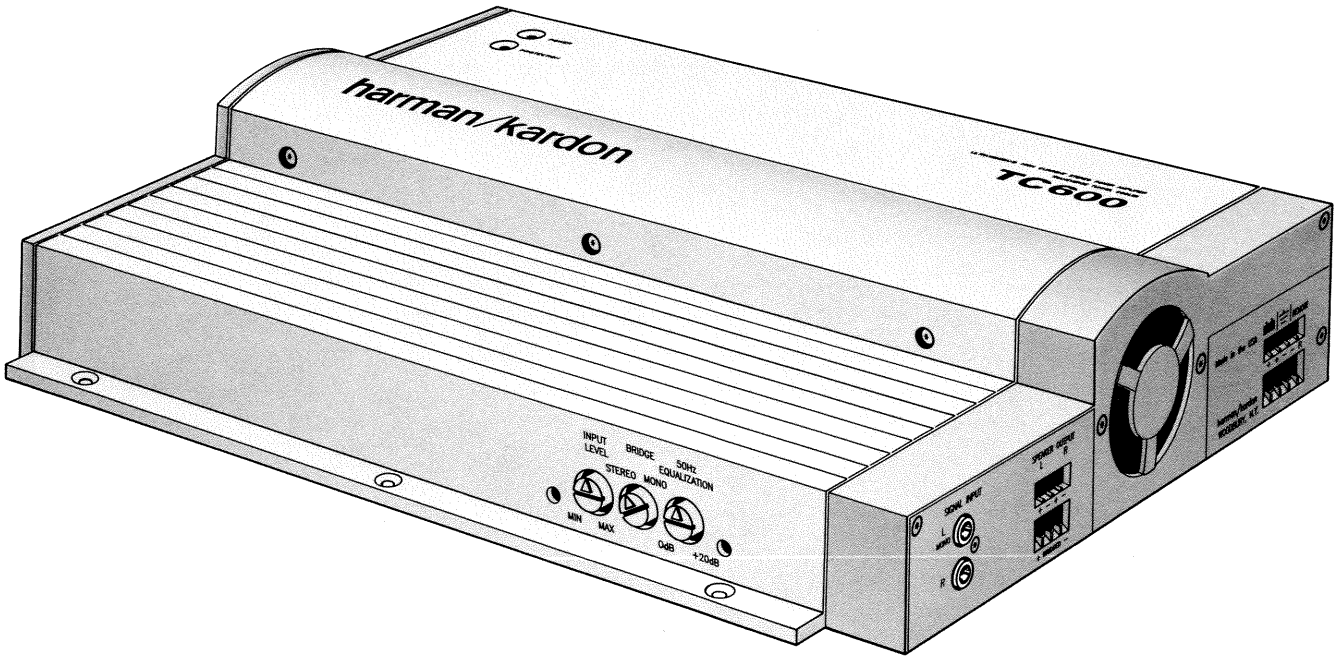
The Harman Kardon

TC600

Manual No. TC600-1

ULTRAWIDEBAND HIGH CURRENT TRANSVERSE TUNNEL COOLED STEREO POWER AMPLIFIER

Technical Manual

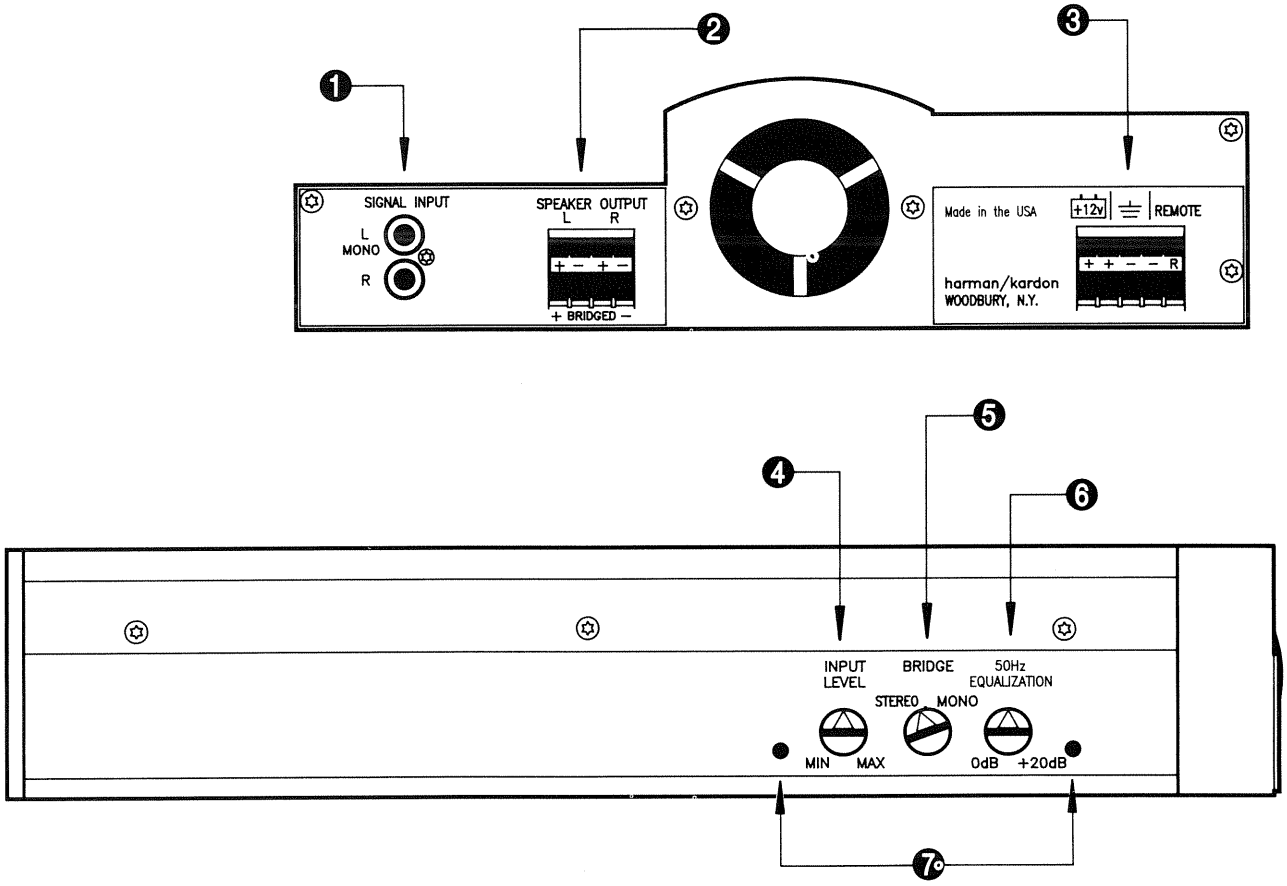


harman/kardon
240 CROSSWAYS PARK WEST, WOODBURY, N.Y. 11797
PRINTED IN USA 1112-TC600-1 P910530 2000

CONTENTS

COMPONENTS AND THEIR FUNCTION..... 1
SPECIFICATIONS..... 2
DISASSEMBLY PROCEDURES..... 2
REPLACEMENT OF PARTS..... 2
GENERAL UNIT EXPLODED VIEW..... 3
GENERAL UNIT PARTS LIST..... 4
ELECTRICAL PARTS LIST..... 5
ADJUSTMENT PROCEDURES..... 8
CIRCUIT DESCRIPTIONS..... 9
IC FUNCTIONAL BLOCK DIAGRAMS..... 11
BLOCK DIAGRAM..... 12
PACKAGE PARTS LIST..... 13
PACKAGE..... 14
SCHEMATIC DIAGRAM..... 16
WIRING DIAGRAM..... 17

COMPONENTS AND THEIR FUNCTION



1. **Signal Input Connectors**
2. **Speaker Output Connectors**
3. **Battery/Remote Connectors**
4. **Input Level Adjustment**
5. **Bridge Mode Switch**
6. **50Hz Equalization Adjustment**
7. **Common-Mode Rejection Trim Adjustment**

SPECIFICATIONS

Power Output, RMS:	600 Watts Continuous Power 200 Wx2 Channels @ 4 ohms 300 Wx2 Channels @ 2 ohms 600 Wx1 Channel @ 4 ohms
HCC (High Instantaneous Current Capability):	±100A
THD (4 ohms/2 ohms) :	No more than 0.1%/0.2%
Power Bandwidth:	10 Hz to greater than 100 kHz
Frequency Response:	10 Hz to 100 kHz, +0, -3 dB
Signal-To-Noise Ratio:	No less than 100 dB
Input Sensitivity: (Continuously Variable Line Level to High Level)	0.27 V to 2.6 V
Input Impedance:	15k-ohm nominal
Power Supply:	DC +14.4 V (9.8 V - 15.7 V usable), negative ground
Typical Current Requirements:	
Idle	5 A
Full power music signal	20 A (4 ohms/ch)
Full power music signal	30 A (2 ohms/ch)
Full power sine wave	60 A (4 ohms/ch)
Full power sine wave	90 A (2 ohms/ch, 4 ohm bridged)
Dimensions (LxWxH)	16-3/8" x 13" x 3-1/8" 416 x 330 x 79 (mm)
Weight	14.0 lb. (6.36 kg)

DISASSEMBLY PROCEDURES

NOTE: Before trying to disassemble the TC600, disconnect all wiring.

STEP 1

Remove right and left hand End Panels by unscrewing five 6-32x1 1/2" (Ref. No. 105) and one 4-40x9/16" (Ref. No. 095) on the right hand End Panel and five 6-32x1/2" (Ref. No. 100) on the left hand End Panel.

STEP 2

Remove three screws 6-32x5/16" (Ref. No. 090) from the side of the Center Cover (Ref. No. 055).

STEP 3

Remove six screws 6-32x1/4" (Ref. No. 110) from the underside of the Bottom Cover and carefully lift the top cover assembly off. Carefully remove the Fan Assembly plug (Ref. No. J1) and LED Assembly plug (Ref. No. J2) from the Printed Circuit Board Assembly.

STEP 4

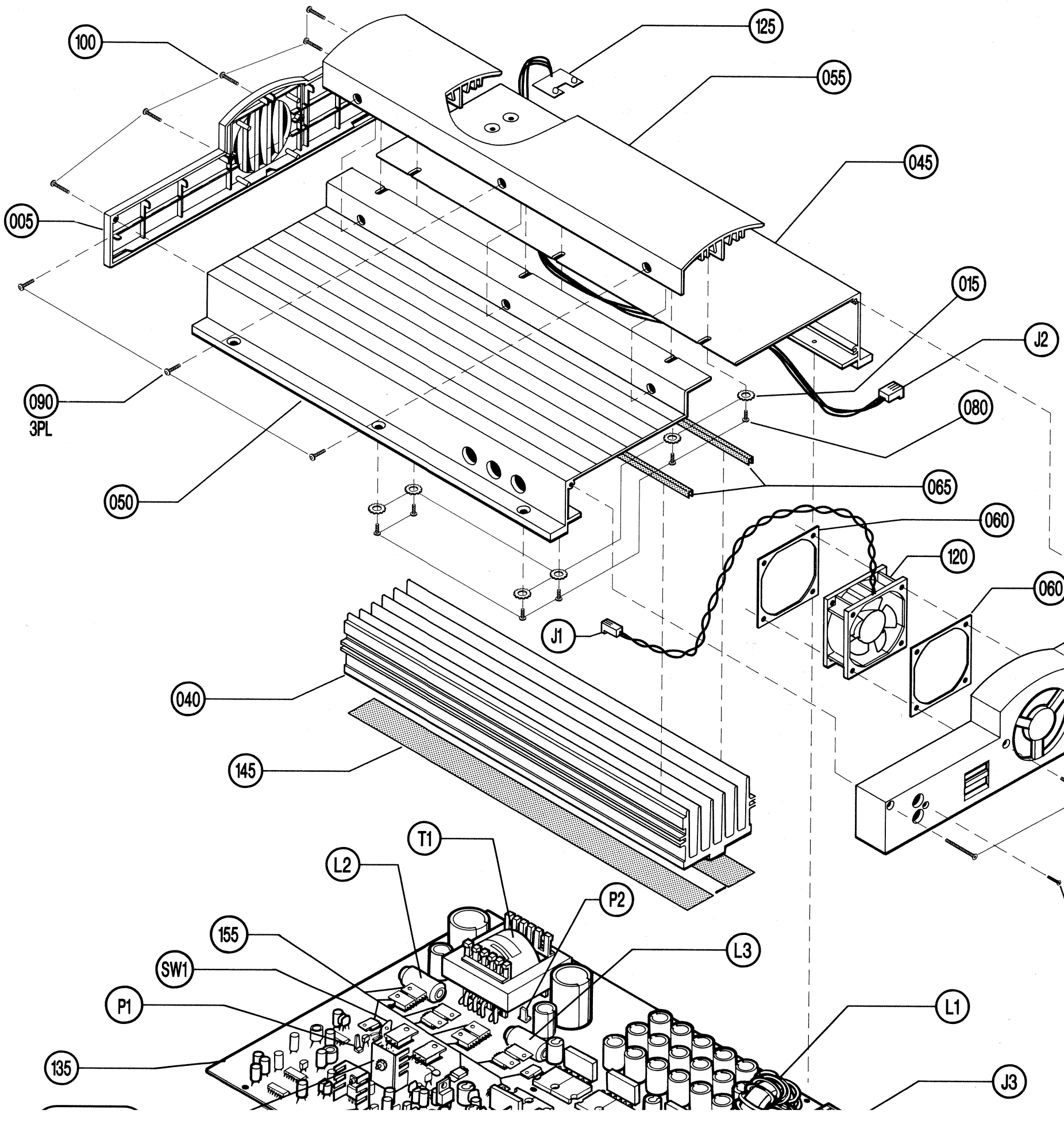
To remove the Bottom Cover from the Printed Circuit Board Assembly unscrew three screws 6-32x1/2" (Ref. No. 085). To remove the heatsink unscrew the remaining twenty screws 6-32x1/2" and carefully lift the circuit board off of the heatsink.

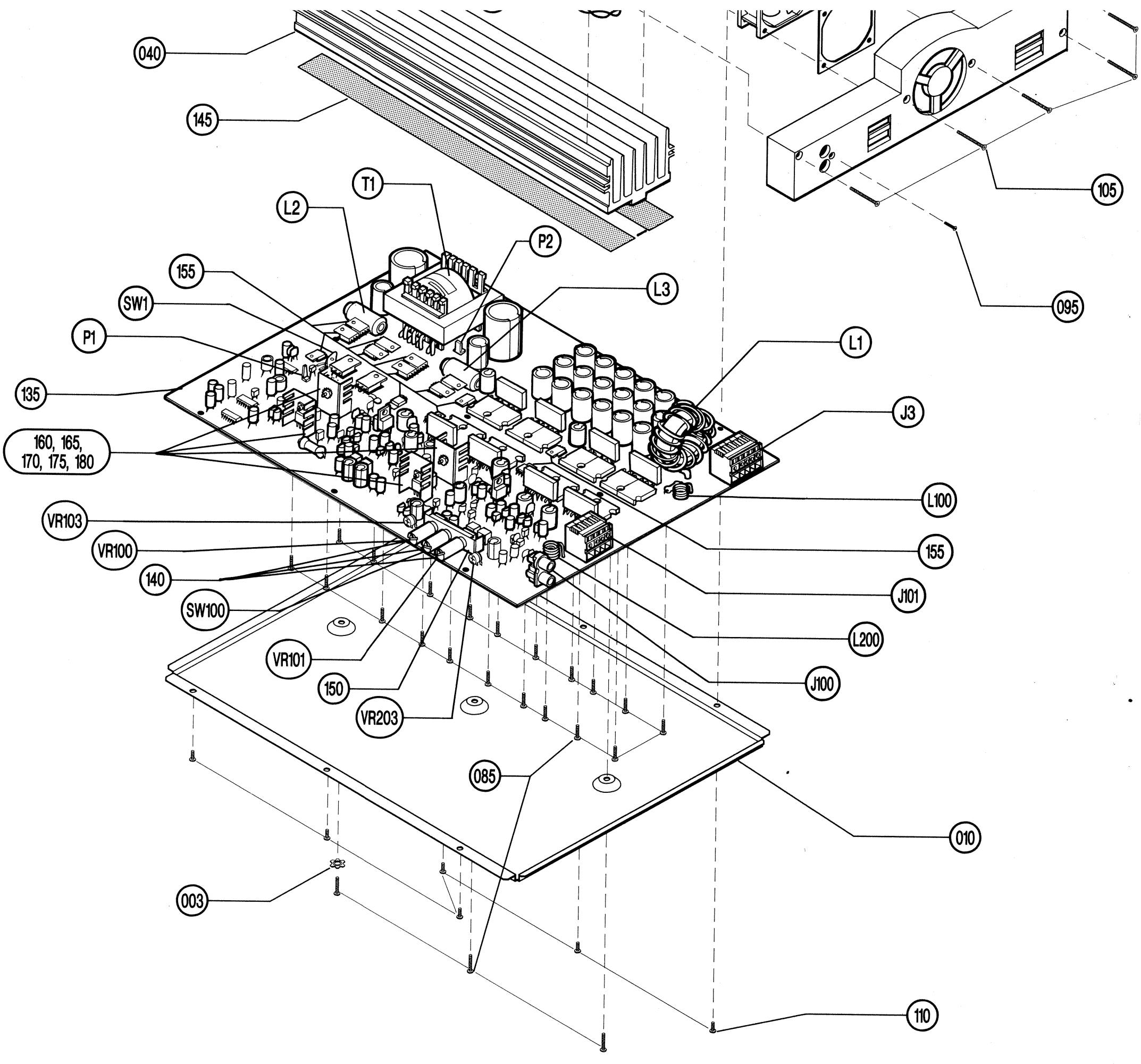
REPLACEMENT OF PARTS

If it is determined that a part under the heatsink requires replacement, carefully desolder the part's leads using solder wicking braid and a soldering iron; it may be necessary to wick away solder on both sides of the board. Remove and verify the part's failure. Replace the part with a known good part making sure to form a part's leads to match those of the removed part. Make sure that any shimming or other supporting materials remains attached to the circuit board. In particular, if replacement of Q119 and/or Q219 is necessary, make sure that the flat surfaces of these parts are parallel to the circuit board. If necessary clean and reapply thermal compound to the heatsink mounting surface. With the mounting surface of the heatsink facing upward, turn the board upside down and carefully position over the heatsink, visually aligning the mounting holes of sink and board. Reinstall the fourteen screws using a torque wrench set to 8 inch-pounds. The remainder of assembly is the reverse of disassembly.

GENERAL UNIT EXPLODED VIEW

(Refer to GENERAL UNIT PARTS LIST)




040
145
105
T1
L2
P2
155
L3
095
SW1
P1
L1
135
J3
160, 165,
170, 175, 180
L100
VR103
155
VR100
140
J101
SW100
L200
VR101
J100
150
VR203
085
010
003
110

GENERAL UNITS PARTS LIST

Ref. No.	Part No.	Description
003	51901-001	#6 External Star Washer
005	50481-xxx*	Left Hand End Panel
010	5059	Bottom Cover
015	51879-001	#6 Flat Washer
040	50599	Heatsink
045	50600-xxx*	Upper Cover
050	50601-xxx*	Lower Cover
055	50602-xxx*	Center Cover
060	50619	Fan Gasket
065	50620	Heatsink Gasket
070	51201-xxx*	Right Hand End Panel
080	51878-001	Screw, 6-32 x 3/8"
085	51215	Screw, 6-32 x 1/2"
090	51880-001	Screw, 6-32 x 5/16"
095	51217*	Screw, 4-40 x 9/16"
100	51218*	Screw, 6-32 x 1/2"
105	51219*	Screw, 6-32 x 1 1/2"
110	51319	Screw, 6-20 x 3/8"
120	50617	Fan Assembly
125	51889-001	LED Assembly
135	50598-002	Printed Circuit Board Assembly
140	50896-001	Knob
145	50920-001	Heatsink Insulator Strip
150	51168	Support Bracket
155	51806-001	Nomex TO-220 Shim Tape
160	HM36-0444	TO-220 Heatsink
165	HM36-0472	Insulator Pad
170	HM36-0363	Nylon Bushing
175	HM30-0208	Screw, 4-40 x 3/8
180	H100-15197	Nut, 4-40
J1	51193	Connector, 2 Pin, Female
J2	50897	Connector, 3 Pin, Female
J3	50399	Terminal Block, 5 Position
J100	50660	Jack, 2 Position, RCA Type
J101	50398	Terminal Block, 4 Position
L1	50641	Inductor, Toroidal, 560 µH
L2, 3	50635	Inductor, 5.0 µH
L100, 200	50638	Inductor, 1.0 µH
P1	50892	Connector, 2 Pin, Male
P2	50999	Connector, 3 Pin, Male
RT1	50703	PTC, Thermistor, 80°C
SW1	51307	Thermal Switch, 50°C
SW100	50709	Rotary Switch
T1	51253-003	Transformer, High Frequency Power
VR100, 101	51122	Potentiometer, 100 kΩ, Reverse Log
VR103, 203	51993-001	Potentiometer, 2kΩ, Trimmer

* Difference in cosmetic treatment results in variable Part No.'s. If you have a silver amplifier, Ref. No.'s 005, 045, 050, 055, and 070 will use a -001 suffix; for black amplifiers, use a -002 suffix. Part No.'s shown for Ref. No.'s 095, 100, 105 are for use with silver amplifiers; for black amplifiers Ref. No. 095 will be 51222; 100 will be 51212; 105 will be 51223.

ELECTRICAL PARTS LIST

RESISTORS

Ref. No.	Part No.	Description
ER100, 101, 102, 103 200, 201, 202, 203	50725-001	0.22Ω,±10%, 5W, (Dual Pkg)
R1, 11	R050-2231	470Ω, ±5%, 1/2W
R2, 4, 5, 28, 34, 40, 44, 49,	C185-01003-00	100kΩ, ±5%, 1/8W
R3, 108, 114, 127, 139, 140, 164, 208, 214, 227, 239, 240, 264	HM185-01000-00	100Ω, ±5%, 1/8W
R6, 25	50392-013	1.0MΩ, ±5%, 1/8W
R7, 29, 38, 45, 52 54, 71, 117, 134, 135, 136, 152, 160, 165, 166, 217, 234, 235, 236, 252, 260, 265, 266	HM185-01001-00	1.0kΩ, ±5%, 1/8W
R8, 10, 12, 16, 17, 20, 27, 31, 39, 41, 42, 56, 67, 112, 116, 142, 173, 174, 175, 176, 179, 181, 212, 216, 242, 273, 274, 275, 276, 279, 281	HM185-01002-00	10kΩ, ±5%, 1/8W
R9	C185-01801-00	1.8kΩ, ±5%, 1/8W
R13	C185-06800-00	680Ω, ±5%, 1/8W
R14	50900-003	180Ω, ±5%, 1/2W
R15	50900-002	82Ω, ±5%, 1/2W
R18, 51	50392-014	43kΩ, ±5%, 1/8W
R19	C185-07502-00	75kΩ, ±5%, 1/8W
R21, 46, 120, 125, 220, 225,	HM185--3900-00	390Ω, ±5%, 1/8W
R22, 48	50392-015	20kΩ, ±5%, 1/8W
R23, 24	C185-02702-00	27kΩ, ±5%, 1/8W
R26, 47, 105 111, 205, 211	C185-03902-00	39kΩ, ±5%, 1/8W
R30, 33, 68, 168, 169 268, 269	HM185-02202-00	22kΩ, ±5%, 1/8W
R32, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 128, 130, 131, 158, 159, 228, 230, 231, 258, 259,	50392-017	33Ω, ±5%, 1/8W
R35, 50, 118, 126, 218, 226	C185-04701-00	4.7kΩ, ±5%, 1/8W
R36, 186, 286	50392-016	560Ω, ±5%, 1/8W
R37	HM185-02204-00	2.2MΩ, ±5%, 1/8W
R43, 141,241	51184-002	680Ω, ±5%, 5W
R55	50392-023	75Ω, ±5%, 1/8W
R100, 102, 200, 202	50180-106	4.53kΩ, ±1%, 1/8W
R101, 103, 201, 203	50180-041	4.99kΩ, ±1%, 1/8W
R104, 119, 204, 219	50180-004	8.25kΩ, ±1%, 1/8W
R106, 206	HM186-01102-00	11.0kΩ, ±1%, 1/8W
R107, 113, 180, 207, 213, 280,	C185-03301-00	3.3kΩ, ±5%, 1/8W
R109, 115, 209, 215	HM185-01800-00	180Ω, ±5%, 1/8W
R110, 144, 147, 210, 244, 247	HM185-08200-00	820Ω, ±5%, 1/8W
R121, 221	50180-116	80.6Ω, ±1%, 1/8W
R122, 222	C185-02401-00	2.4kΩ, ±5%, 1/8W
R123, 223	50392-021	47Ω, ±5%, 1/8W
R124, 224	50180-015	43.2kΩ, ±1%, 1/8W

ELECTRICAL PARTS LIST (Cont.)

Ref. No.	Part No.	Description
R129, 229	HM185-04301-00	4.3kΩ, ±5%, 1/8W
R137, 138, 237, 238	C185-01201-00	1.2kΩ, ±5%, 1/8W
R143, 243	51157-001	680Ω, ±5%, 2WR
145, 146, 148, 149, 245, 246, 248, 249	50392-018	200Ω, ±5%, 1/8W
R151, 251	HM186-03012-00	30.1kΩ, ±1%, 1/8W
R153, 253	HM185-08201-00	8.2kΩ, ±5%, 1/8W
R154, 155, 254, 255	C185-0200-00	220kΩ, ±5%, 1/8W
R156, 157, 256, 257	50392-004	10Ω, ±5%, 1/8W
R161, 261	C185-03001-00	3.0kΩ, ±5%, 1/8W
R162, 163, 262, 263	50579-001	10kΩ, ±5%, 1/2W
R167, 170, 267, 270	51225-001	10MΩ, ±5%, 1/8W
R171, 172, 271, 272	51226-001	18kΩ, ±5%, 1/4W
R177, 277	51126-001	0.5Ω, ±5%, 1W
R178, 278	R125-1524	10Ω, ±5%, 1W
R182, 282	50180-090	6.34kΩ, ±1%, 1/8W
R183, 283	50180-107	3.65kΩ, ±1%, 1/8W
R184, 185, 284, 285	50180-109	475Ω, ±1%, 1/8W
RT1	50703	PTC, Thermistor, 80°C
VR102, 202	50711	Potentiometer, 5 kΩ, Trimmer

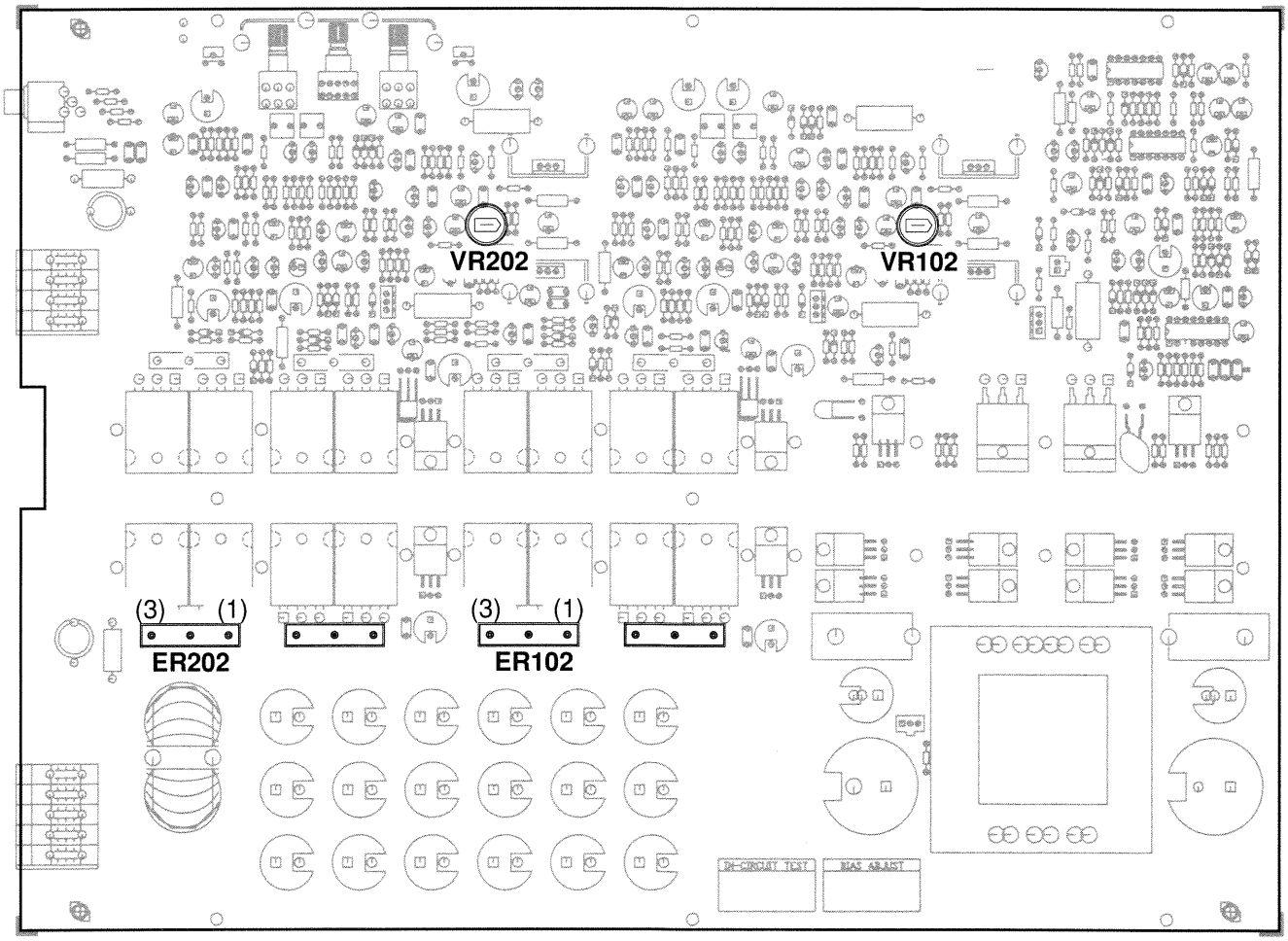
CAPACITORS

C1, 2, 5, 6, 7, 8, 105, 106, 107, 108, 112, 113, 117, 118, 205, 206, 207, 208, 212, 213, 217, 218	50173	0.1µF, ±5%, 50V
C3	HM14-0594	3.3 nF, ±5%, 50V
C4	C14-0673	82 nF, ±5%, 50V
C100, 101, 200, 201	50436-001	150pF, ±5%, 50V, NPO
C102, 202	HM14-0585	47pF, ±5%, 500V, NPO
C103, 203	51711-002	22pF, ±5%, 100V, COG
C104, 204	50407	270pF, ±5%, 63V, COG
C110, 111, 210, 211	C050-1605	10pF, ±5%, 50V, COG
C114, 214	HM14-0580	33nF, ±5%, 50V
C115, 116, 215, 216	51104-001	2.2µF, ±5%, 63V
C119, 120, 219, 220	C14-0650	2.2µF, 50V
CP1, 3, 10, 109, 209	HM14-0576	22µF, 25V
CP2, 9,	HM14-0577	1.0µF, 50V
CP4, 5, 7, 11	C016-1600	10µF, 16V
CP6	C14-0647	470µF, 16V
CP8	50911-003	3.3µF, 50V
CP12	C015-0100	100µF, 25V
CP13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30	HM14-0573	470µF, 25V
CP31, 32	50362-001	470µF, 50V
CP33, 34	50362-002	10000µF, 50V
CP35, 114, 115, 121, 214, 215, 221	HM14-0600	10µF, 50V
CP100, 101, 105, 106, 200, 201, 205, 206	51102-001	33µF, 25V
CP102, 103, 112, 113, 202, 203, 212, 213	51094-001	1000µF, 16V
CP104, 116, 204, 216	52200-001	220µF, 16V
CP110, 111, 117, 120, 210, 211, 217, 220	C14-0646	100µF, 10V
CP118, 119, 218, 219	C050-1607	100µF, 50V

ELECTRICAL PARTS LIST (Cont.)

Ref. No.	Part No.	Description
INTEGRATED CIRCUITS		
U1	HM13-0382	LM324N, Quad Op Amp
U2	HM13-0498	CD4093BE, Quad Schmitt-Trigger NAND
U3	50621	SG3525A, Switching Regulator Control
U101, 201	HM13-0408	MC7915CT, Voltage Regulator
TRANSISTORS		
Q1	50577	P2N3019
Q2, 8, 9, 101, 103, 109, 136, 201, 203, 209, 236	HM13-0414	2N3906
Q3	50702	P2N4033
Q4	HM13-0407	BUZ71
Q5, 6, 20, 100, 102, 108, 110, 134, 135, 200, 202, 208, 210, 234, 235	HM13-0413	2N3904
Q7, 119, 219	50363	MPSA12
Q10, 11, 12, 13, 14, 15, 16, 17, 18, 19	50157	MTP50N05E
Q104, 106, 204, 206	S100-1521	2N5210
Q105, 107, 111, 114, 133, 205, 207, 211, 214, 233	HM13-0417	MPS8599
Q112, 113, 212, 213	HM13-0415	MPS8099
Q115, 215	50573	MPSW06
Q116, 216	50575	MPSW56
Q117, 121, 217, 221	50569	2SA968
Q118, 120, 218, 220	50570	2SC2238
Q122, 125, 126, 129, 222, 225, 226, 229	50572	2SC3281
Q123, 124, 127, 128, 223, 224, 227, 228	50571	2SA1302
DIODES		
CR1	50626	1N964B
CR2, 3, 5, 7, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 22, 101, 102, 106, 107, 201, 202, 206, 207	C13-0482	1N4148
CR4, 6, 100, 103, 200, 203	S100-1503	1N751A
CR8, 9, 110, 210	S100-1623	1N4002
CR18, 108, 109, 208, 209	HM185-10000-00	0Ω (resistor), 1/8W
CR21	50623	1N4746A
CR23	50625	FEP30DP
CR24	50624	FEN30DP
CR25	S100-1508	1N963B
CR104, 204	S100-1509	1N965B
C111, 112, 211, 212	52212-001	FDH333
DS100, 200	H050-250	LED, Red, T-1, LT311G

ADJUSTMENT PROCEDURES



BIAS ADJUSTMENT

Connect Power (+12V-14.4V) to the amplifier and remote terminal. Leave the input and output connectors open.

Step	Terminals to be connected	Adjustment Location	Adjustment Method
1	Connect digital voltmeter across 1, 3 (bare wire leads of ER102)	VR102	Turn with small screwdriver for voltmeter reading of 13.2mV
2	Connect digital voltmeter across 1, 3 (bare wire leads of ER202)	VR202	Turn with small screwdriver for voltmeter reading of 13.2mV

CIRCUIT DESCRIPTIONS

SWITCHING REGULATOR

Power from the automobile's battery/alternator is filtered by L1 and CP13-CP30 and feeds the center tap of the primary winding of T1. Each end of the primary is driven by power MOSFETs Q10-Q19, which are turned on and off in alternate groups by U3. The secondary winding of T1 has its center tap tied to audio ground; the voltages at each end of the secondary are rectified by the dual-rectifiers CR23 and CR24, and the rectified voltages are filtered by L2, L3, CP31, CP32, CP33, CP34. The positive output voltage is attenuated by R47/R45 and combined with a current derived from the negative output voltage via R51, CR22, R52, R54, and Q9, and the resulting signal drives the inverting input of the error amplifier in U3. The non-inverting input of U3 is supplied with a 2.5V reference by voltage divider R42/R56 derived from VREF, pin 16 of U3.

U3 receives power initially from the control section supply voltage filter-clamp via Q3 and CR17; when the positive output voltage of the switching regulator exceeds the control section supply voltage, U3 becomes powered from the switching regulator via R43 and CR20. CR21 clamps the voltage at U3, pin 15, to 18V.

C3 and R50 determine the switching regulator frequency. U3 regulates the output voltages by adjusting the output pulse widths at pins 11 and 14. Transient response is controlled by R48, R49, C4 and C5.

The shutdown terminal of U3, pin 10, is driven high by various conditions: battery line voltage too low or too high; over-temperature; excess current in either or both amplifier outputs. When pin 10 goes high, Q20 is turned on and discharges CP11, the soft-start capacitor, so that the amplifier recovers from the shutdown condition smoothly. This capacitor also causes the power supply voltages to ramp up slowly on initial turn-on.

CONTROL SECTION SUPPLY VOLTAGE FILTER CLAMP

Battery/alternator voltage is filtered and clamped if above 13V by R1, CP1, CR1, and buffered by emitter follower Q1. This provides a power supply voltage of about 12V for the control circuitry and the cooling fan.

REMOTE SENSE

The remote input terminal, J3-5, drives voltage divider R10/R5 which provides an attenuated voltage at U1 pin 2. If the voltage exceeds half of the control section power supply that appears at U1 pin 3, U1 pin 1 goes low, turning on Q2 and Q3. The collector of Q3 rises to about 12 volts, supplying fan voltage, initial power to U3, and turning on the reference voltage.

With 12 volts at the collector of Q3, a 5.1 volt reference is generated by R14/CR6/CP3. A 1.85 volt reference is derived from the 5.1 volt reference by R13 and R21.

OVER/UNDER VOLTAGE PROTECT

Two voltage dividers supply attenuated voltages proportional to the battery/alternator voltage to two op amps that are part of U1. If the battery /alternator voltage falls below 9.8 volts, U1 pin 6 falls below 1.85 volts and the amplifier's output pin 7, goes high (10volts). If the battery/alternator voltage exceeds 15.7 volts, U1 pin 10 exceeds 1.85 volts and this amplifier's output, pin 8, goes high.

If either amplifier's output is high, CP7 charges through either CR13 or CR14 and activates the shutdown terminal of the switching regulator IC, U3 pin 10. Q7 is turned on, which causes DS2, the red LED visible on the top cover, to illuminate. U2 pins 1 and 2 are driven high via R28.

THERMAL PROTECT

RT1 is a positive-temperature-coefficient resistor, or "posistor"; with R29, it forms a voltage divider which drives U1 pin 12. When the heat dissipator temperature reaches 80°C, the voltage at pin 12 exceeds the 1.85 volt reference at pin 13 and this amplifier's output goes high. Q4 is turned on via CR16 and R32, and the fan receives full power. CP7 charges through CR15 and activates the shutdown pin of U3, turns on Q7 thus illuminating DS2, and drives U2 pins 1 and 2 high.

MUSIC-LINKED FAN CONTROL

When Q3 turns on, and its collector rises to 12V, the cooling fan is supplied with power via R15, and operates at low speed. Q4 shunts R15 when turned on by a positive voltage at its gate and supplies full power to the fan. This occurs under two conditions: either because U1 pin 14 goes high (over-temperature condition), or when both thermal switch SW1 opens (indicating a heatsink temperature greater than 50°C) and the amplifier outputs are driven to moderate signal levels (frequent positive peaks of greater than about 3 volts). This threshold is set by diodes CR10, CR11, CR12, CR8 and/or CR9, R26, and the base-emitter characteristic of Q5. The peak voltages are filtered by CP6 and cause Q5 to turn on, turning off Q6 and allows R23 and CR7 to pull the gate of Q4 high, if SW1 is open.

MUTING CONTROL

U2 is a Schmitt-trigger-input quad NAND gate. When CP7 goes high, due to previously discussed conditions, U2 pin 5 goes low immediately, followed by pin 6 going low. U2 pin 4 goes high as pin 5 goes low, which drives U2 pins 8 and 9 high, which causes U2 pin 10 to go low. Thus, Q8 turns on via R44 and supplies positive current to the "mute" line. If the voltage at pins 1 and 2 of U2 goes low, pin 3 goes high. Pin 5 goes high immediately; CP8 charges through R35 and R37 only (CR19 being reverse-biased) and reaches the threshold voltage of U2 pin 6 in about six seconds. When both pins 5 and 6 are high, pin 4 goes low, pin 10 goes high, and Q8 is turned off, open-circuiting the mute line.

LINE LEVEL AMPLIFIERS

Input signals from source components connected to RCA jacks labelled "Signal Input" are differentially amplified by the line-level amplifier section. The left channel input's center conductor feeds the base of Q100, the non-inverting input of the first line-level stage, via R184, CP100, R100 and R101. The left channel input's shield conductor feeds the emitter of Q100, the inverting input of this stage. In contrast, the connections for the corresponding right channel stage are reversed. Proper overall polarity from input to power amplifier output is

preserved by reversing speaker polarity designations at the "Speaker Output" connector. VR103 and VR203 adjust to compensate for the output impedance of the selected source component, to optimize common-mode noise rejection.

Each line-level stage consists of an NPN input device (Q100/Q200) whose collector drives a PNP device (Q101/Q201) with substantial local negative feedback from R108/R208.The output is taken from the collector of the PNP device with a current-source load formed by Q134/Q234, R109/R209, R180/R280, and DS100/DS200. Overall negative feedback is applied via R106/R206. Stage gain is approximately unity for a 1.0 kohm source impedance. Transient response is controlled via C102/C202.

Rotary switch SW1, located on the side of the amplifier chassis and labelled "Bridge", "Stereo/Mono", is shown in the "Mono" position, in which the junction of R184 and CP100 is tied to the junction of R285 and CP200, and the junction of R185 and CP101 is tied to the junction of R284 and CP201. An input signal at the left channel input jack thus drives both the left channel and right channel line-level amplifiers, with the right channel inverting polarity.

The output of the first stages drive the second stages, consisting of similarly arranged components; only the non-inverting inputs are used. The gain of each second stage is determined by the ratio of R112/R212 to the impedance of the parallel combination of R111/R211 with the series connection of VR100, R110/R210, and CP104/CP204. VR100 is a dual potentiometer whose adjustment is made by turning the knob labelled "Input Level". At full C.C.W. rotation ("min") the gain of each second stage is 1.29 at midband. At full C.W. rotation ("max") the gain is 12.3.

The second stage outputs are taken from the collectors of Q103/Q203, and drive voltage dividers R182-R183/R282-R283. The overall voltage gain at the inputs of the output stages (bases of Q104/Q204) is 3.7 for full C.W. rotation of the input level control.

The output stages of the line-level amplifier section consist of similarly arranged components, Q104/Q204, Q105/Q205, and associated passive components. These stages have a nominal midband voltage gain of 1.06. The outputs are taken from the collectors of Q105/Q205.

Bass boost centered at 50 Hz is generated by active circuits (Q106/Q206, Q107/Q207, and associated passive components) which simulate a series R-L-C circuit, which affects the output stage gain in accordance with the setting of dual potentiometer VR101 (labelled "50 Hz equalization" on the side of the amplifier chassis). With VR101 adjusted fully C.W., maximum boost at 50 Hz is about 20 dB.

POWER AMPLIFIERS

Output signals from the line-level amplifiers connect to the power amplifier inputs via R135/R235, with muting performed by shunt transistors Q108/Q208, and with high frequency filtering by C104/C204. The amplifiers consist of dual complementary differential pairs (Q112-Q113/Q212-Q213, and Q111-Q114/Q211-214) with one collector of each pair driving complementary compound gain stages with current outputs (Q116-Q117, Q216-Q217; Q115-Q118, Q215-Q218). Emitter currents are supplied by current sources: Q109/Q209, Q110/Q210, and associated components. Substantial local negative feedback is applied in each circuit section. Current outputs of the second stages are loaded by 10k-ohm resistors to common and the inputs of the driver stages, common-collector-connected transistors Q120/Q220, Q121/Q221. These transistors drive the common-collector composite output stages, with eight devices, four of each polarity, per channel (Q122/Q222, Q125/Q225, Q126/Q226, Q129/Q229, NPN devices;Q123/Q223, Q124/Q224, Q127/Q227, Q128/Q228, PNP devices). Temperature compensation for the driver and output stages is provided by Q119/Q219, R160/R260, R161/R261, and VR102/VR202; Q119/Q219 are in thermal contact with the heatsink. Q134/Q234 reduce the collector currents and hence the base currents of Q119/Q219, and thus improve the performance of the bias circuitry by causing lower loading of the resistive divider networks (R160/R260, R161/R261, VR102/VR202). Quiescent output stage current is set to a nominal 30 mA per "each output device" corresponding to 13.2 mV across ER100/ER200 (terminals 1 and 3), which is adjusted by VR102/VR202.

Reactive loads are isolated from the amplifier outputs by R177/R277, L100/L200. R178/R278 and C114/C214 prevent spurious oscillation. Primary transient response is controlled by C110/C210, C111/C211, and the capacitance between collector-connected mounting surfaces of Q117/Q217, Q118/Q218, and their associated (grounded) heatsinks. Overall negative feedback is provided by R151/R251, R153/R253; CP116/CP216 in series with R153/R253 reduce gain at very low frequencies to reduce D.C. output offset.

+15 volts is provided for input stages and the line-level amplifiers by zener diodes CR104/CR204 and dropping resistors R141/R241. -15 volts is provided for input stages and the line-level amplifiers by U101/U201, three-terminal negative voltage regulators. Regulator dissipation is reduced by R143/R243, in series with the regulator input terminals.

VOLTAGE-LINKED OUTPUT CURRENT SENSE/PROTECT

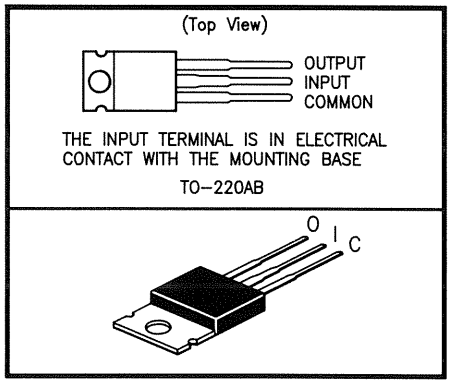
Output current of each power amplifier section is sensed by Q130/Q230, Q131/Q231, which connect via R165/R265, R166/R266, to emitter ballasting resistors ER103/ER203, respectively. For low magnitudes of output voltages, the threshold of conduction for Q130/Q230, Q131/Q231 occurs at output currents (for the overall amplifiers) of about 11 amperes. As the amplifier outputs swing above or below zero volts out, the current sense threshold is increased because of current removed from the sense transistor bases by CR106/CR206, CR107/CR207, R168/R268, R171/R271. Thus a first-order safe-operating-area compensation is achieved.

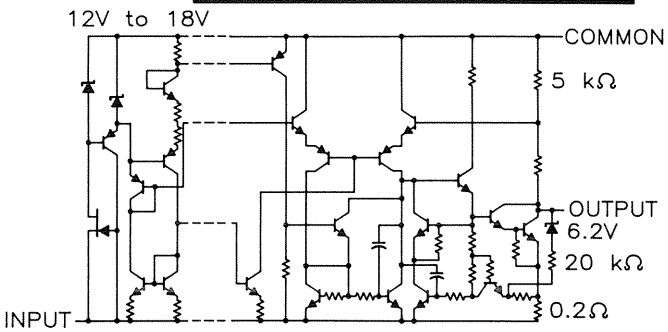
If Q130/Q230 turn on, Q133/Q233 turn on after a short delay, pulling the protect line high and initiating switching power supply shutdown. If Q131/Q231 turn on, Q132/Q232 turn on after a short delay, which turns on Q133/Q233, also driving the protect line high and initiating switching power supply shutdown. Depending on the load resistance, the protection circuitry will cause

the protection LED to flash for 1 second every 1.5 seconds (for a short circuit in the stereo mode), or for less severely low resistance loads, 1 second every 7 seconds. As the protection line goes high, Q7 is turned on via R69; the falling voltage at the collector of Q7 is coupled via CP35 to the inverting input of one of the four op amps of U1 (pin 9). The output of this amplifier responds by going high, which keeps Q7 turned on after the protect line goes low, until CP35 has charged to the new voltage; then the amplifier output returns to the low level, turning Q7 and the protection LED off and starting the time-to-unmute delay. With a very low resistance across the amplifiers' outputs, the voltage-linked current-sensing circuitry will be retriggered as the rail voltages come up again even though the amplifier is still muted. For higher resistance loads, the current-sensing circuitry will not be actuated until the amplifier begins to receive signal drive, following the time-to-unmute delay. Usually when the amplifier is operating in the bridge mode, the output voltage transients as the rail voltages come up will closely track, hence very little current will flow in the output load and the amplifier will wait for the restoration of signal drive to go into the protect mode again (after the delay-to-unmute time).

LM7915 Negative-Voltage Regulator

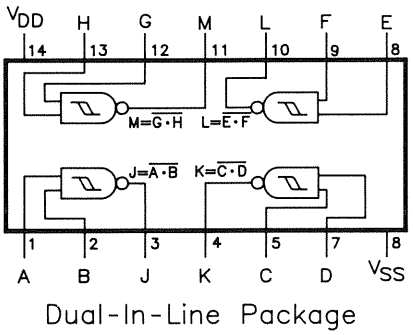
KC PACKAGE





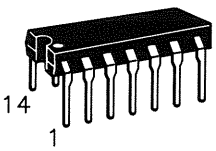
IC FUNCTIONAL BLOCK DIAGRAM

CD4093BC Quad 2-Input NAND Schmitt Trigger



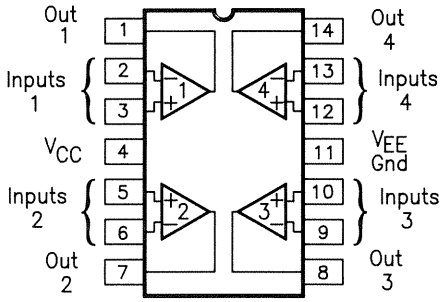
Dual-In-Line Package

LM324A(N) Quad Differential Input Operational Amplifier



N SUFFIX
PLASTIC PACKAGE
CASE 646-06
(LM224, LM324, LM2902 ONLY)

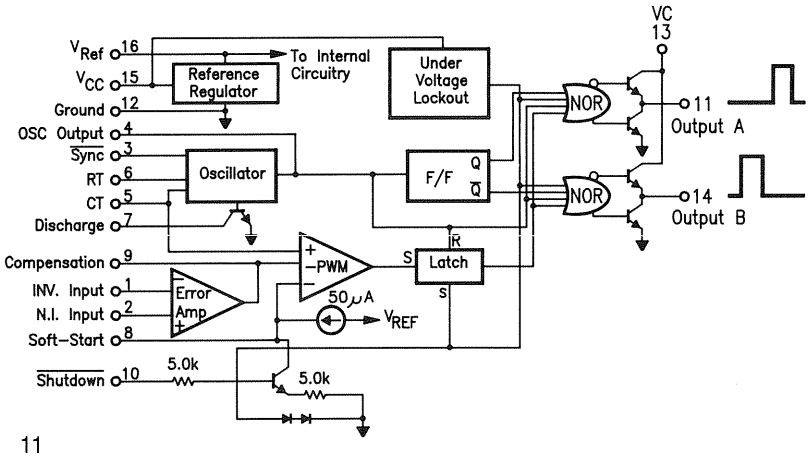
PIN CONNECTIONS



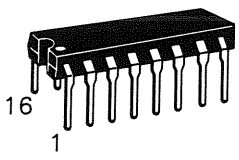
(Top View)

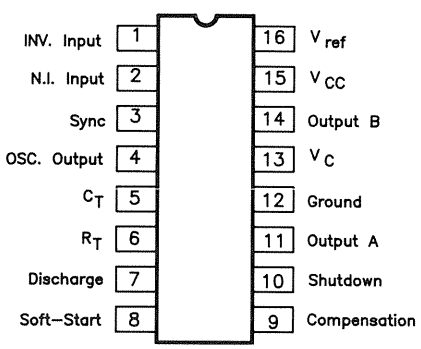
SG3525A Pulse Width Modulator Control Circuit

FUNCTIONAL BLOCK DIAGRAM



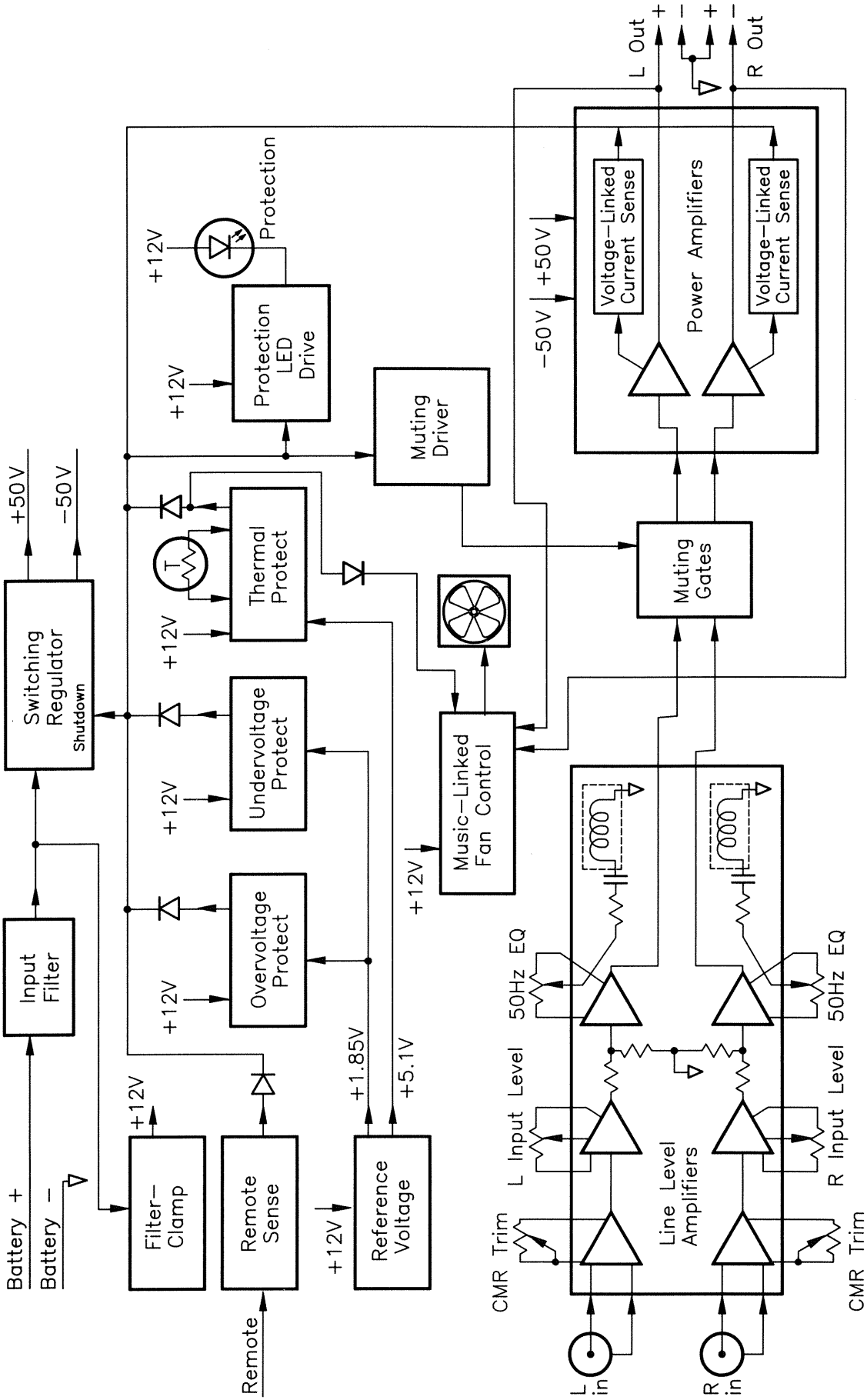
N SUFFIX
PLASTIC PACKAGE
CASE 648-08





(Top View)

BLOCK DIAGRAM



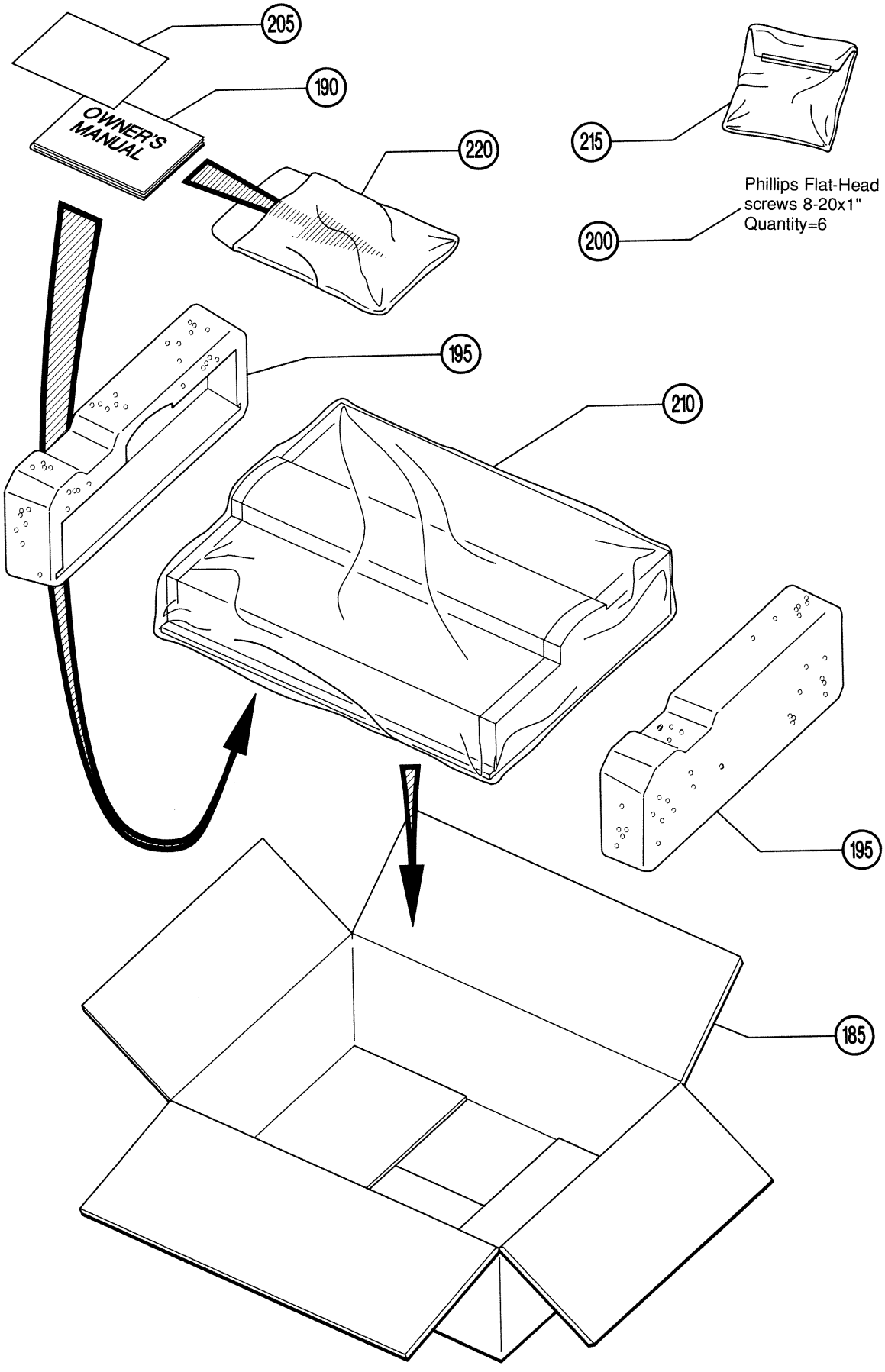
PACKAGE PARTS LIST

Ref. No.	Part No.	Description
185	50605-xxx*	TC600 Display Box
190	50609	Owners Manual
195	50610	Foam Packing
200	51308	Installation Screws
205	51387	Warranty Stations List
210	51647-001	15"x 24" Poly Bag .004
215	P900-15214	2"x 2" Poly Bag .002
220	P900-15215	7"x10" Poly Bag .002

* Ref. No. 185 will have a -001 suffix for silver amplifiers, and will have a -002 suffix for black amplifiers.

PACKAGE

(Refer to PACKAGE PARTS LIST)



SCHEMATIC DIAGRAM

CONTROL SECTION SUPPLY VOLTAGE FILTER-CLAMP

MUSIC LINKED FAN CONTROL CIRCUIT

MUTING CONTROL

REMOTE SENSE

REFERENCE VOLTAGES

OVER/UNDER VOLTAGE PROTECT

THERMAL PROTECT

L.E.D. Assembly (51189-001)
LT321 (GREEN)
LT311G (RED)
J2

Fan Assembly (50617)
J1

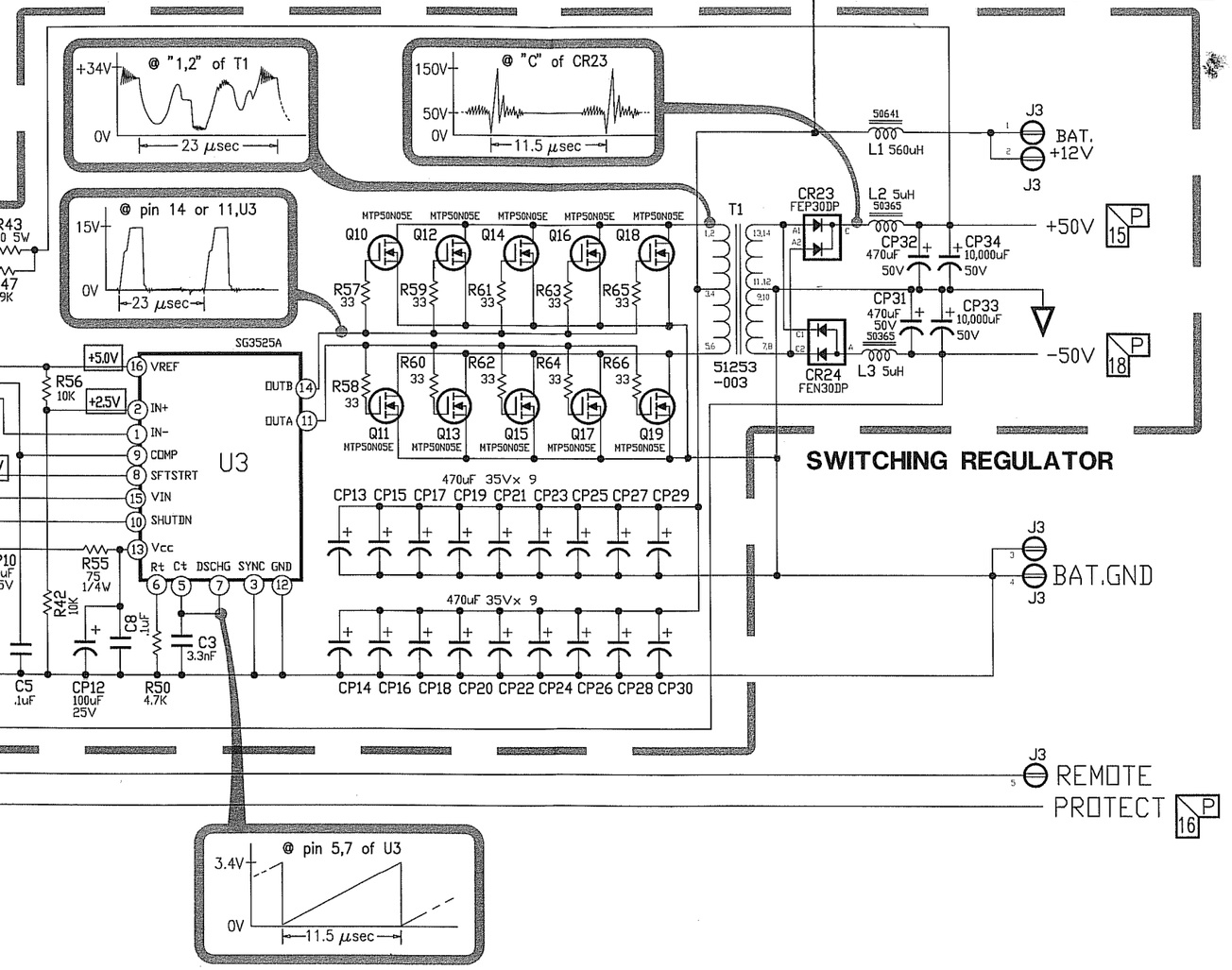
POWER AMPLIFIER SECTION LEFT CHANNEL

VOLTAGE-LINKED OVERCURRENT PROTECT CIRCUIT LEFT CHANNEL

L.OUT+ 13 P

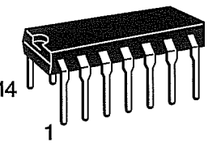
R.OUT+ 17 P

MUTE 13 B 17 B

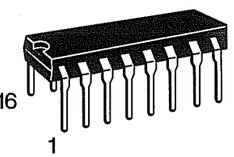


SWITCHING REGULATOR

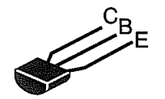
OLTAGE-LINKED
VERCURRENT
ROTECT CIRCUIT
EFT CHANNEL



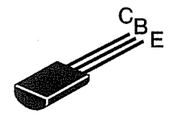
LM324N
CD4093BE



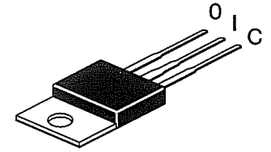
SG3525A



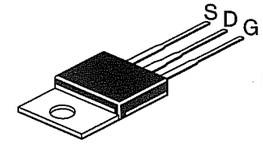
2N3904
2N3906
2N5210
MPS8099
MPS8599



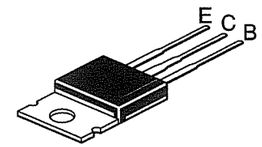
MPSW06
MPSW56
P2N3019
P2N4033



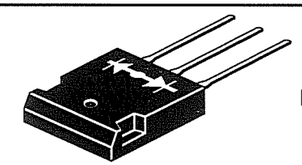
LM7915



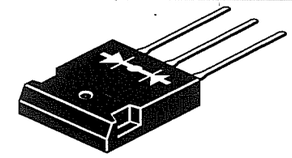
MTP50N05E



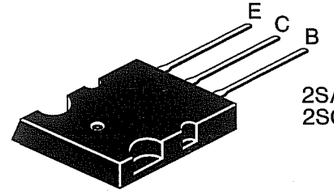
(2S)
A968B
(2S)
C2238



FEN30DP



FEP30DP

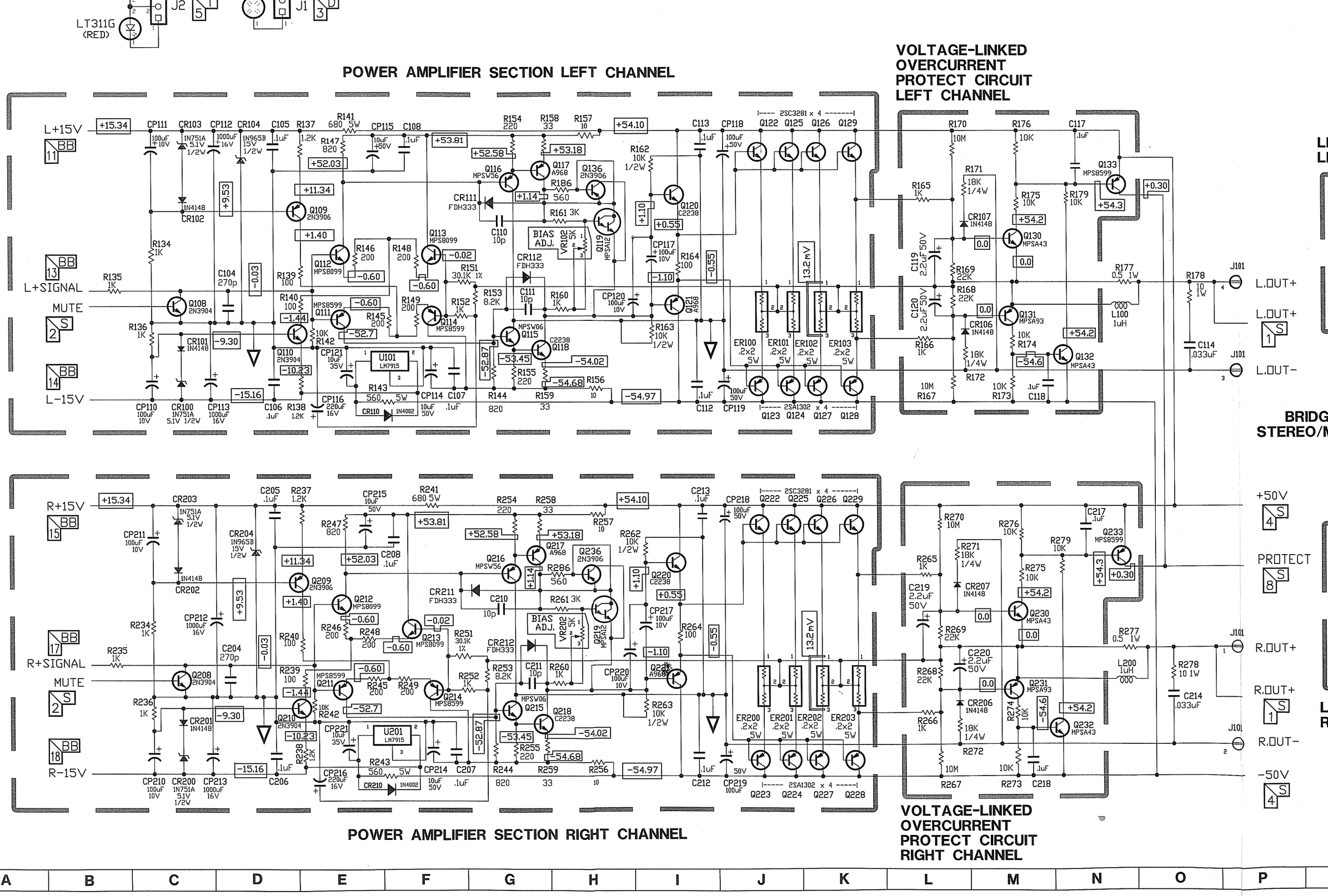


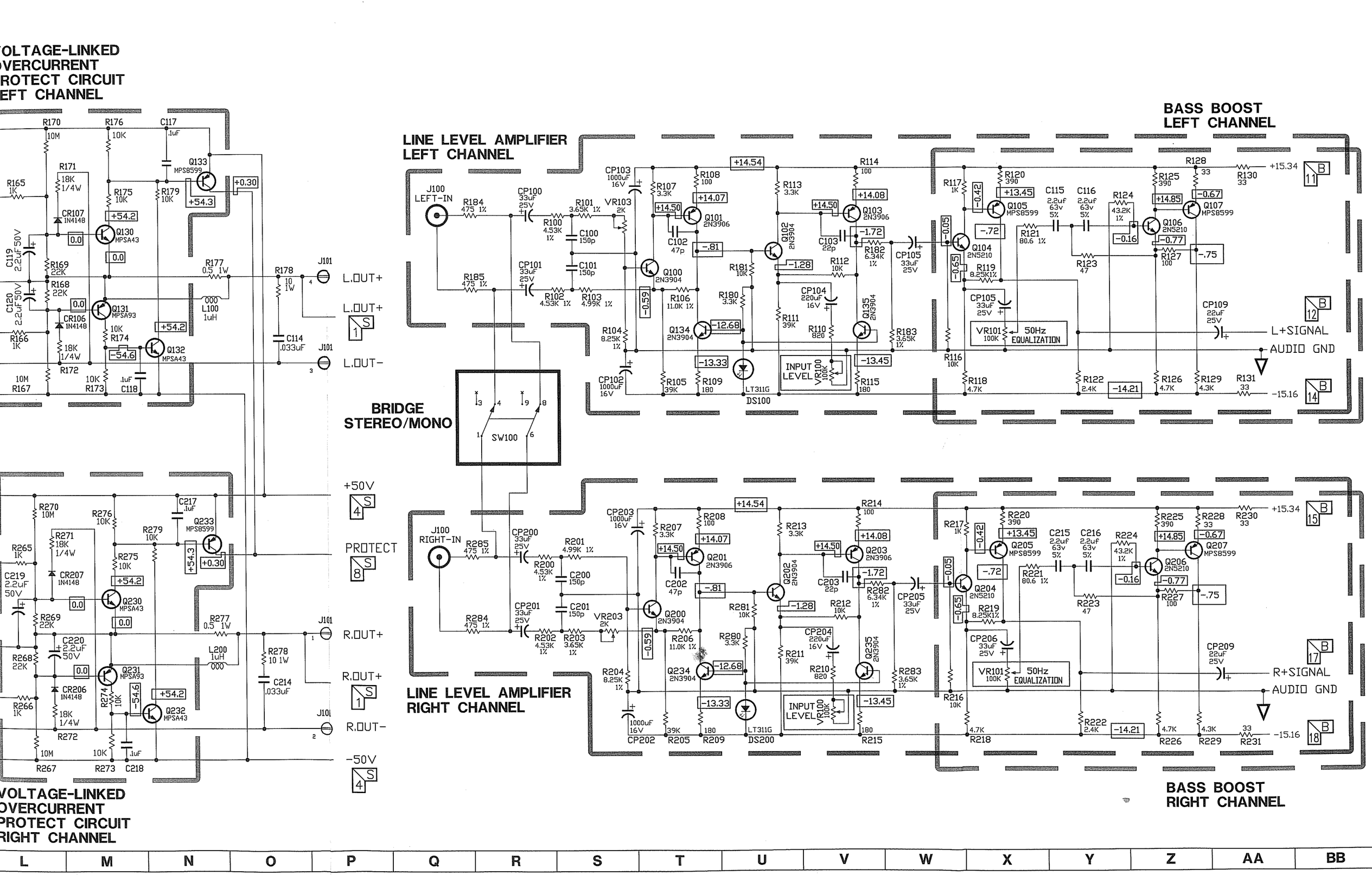
2SA1302
2SC3281

NOTE: ALL RESISTORS ARE 1/8 WATT, UNLESS OTHERWISE SPECIFIED

▽ : DENOTES AUDIO GROUND

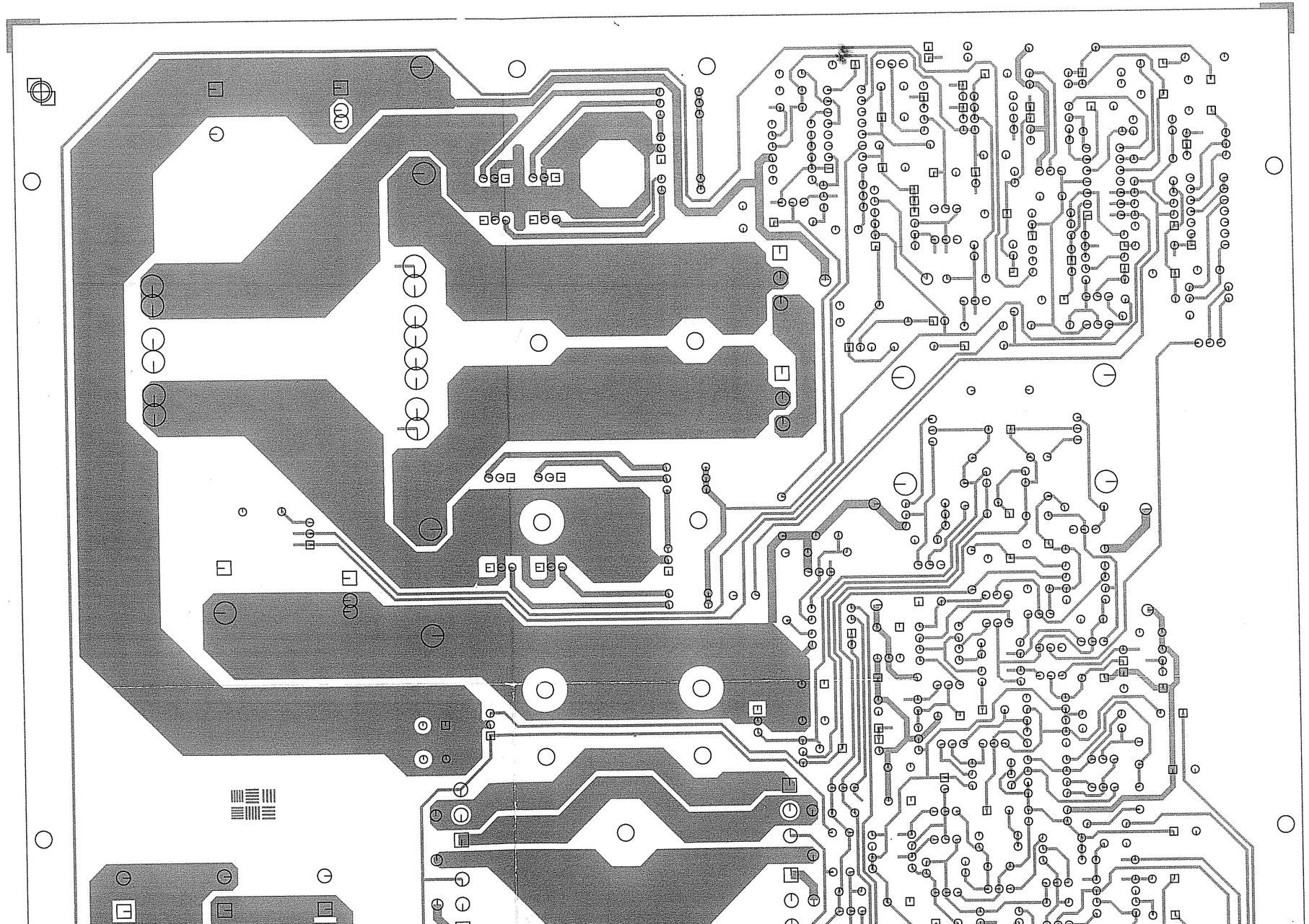
BASS BOOST

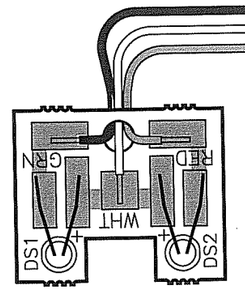

POWER AMPLIFIER SECTION LEFT CHANNEL
VOLTAGE-LINKED OVERCURRENT PROTECT CIRCUIT LEFT CHANNEL
L+15V
L+SIGNAL
MUTE
L-15V
L.OUT+
L.OUT+
L.OUT-
LINE LEV
LEFT CH
J100 LEFT-IN
BRIDGE STEREO/MONO
POWER AMPLIFIER SECTION RIGHT CHANNEL
VOLTAGE-LINKED OVERCURRENT PROTECT CIRCUIT RIGHT CHANNEL
R+15V
R+SIGNAL
MUTE
R-15V
+50V
PROTECT
-50V
R.OUT+
R.OUT+
R.OUT-
LINE LEV
RIGHT C
J100 RIGHT-IN



L M N O P Q R S T U V W X Y Z AA BB

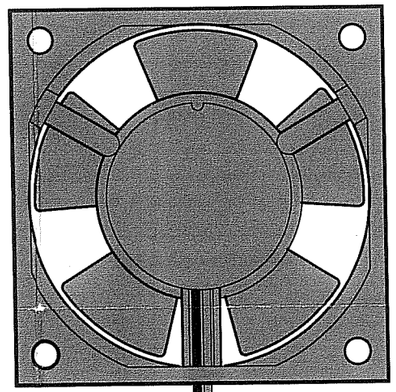
VIRING DIAGRAM

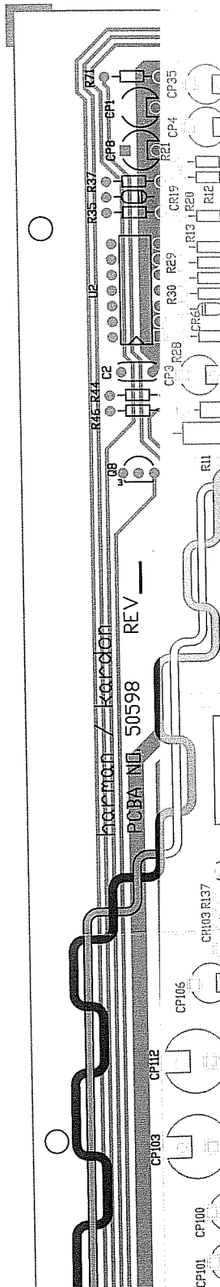


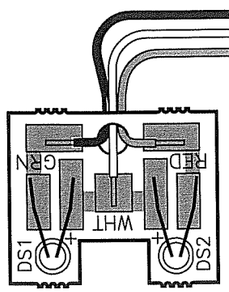


LED Assembly
ref. #125
part #51889-001

Fan Assembly
ref. #120
part #50617

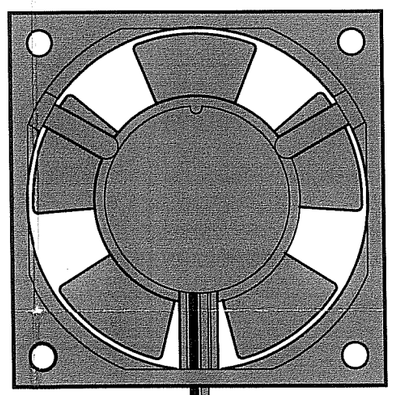


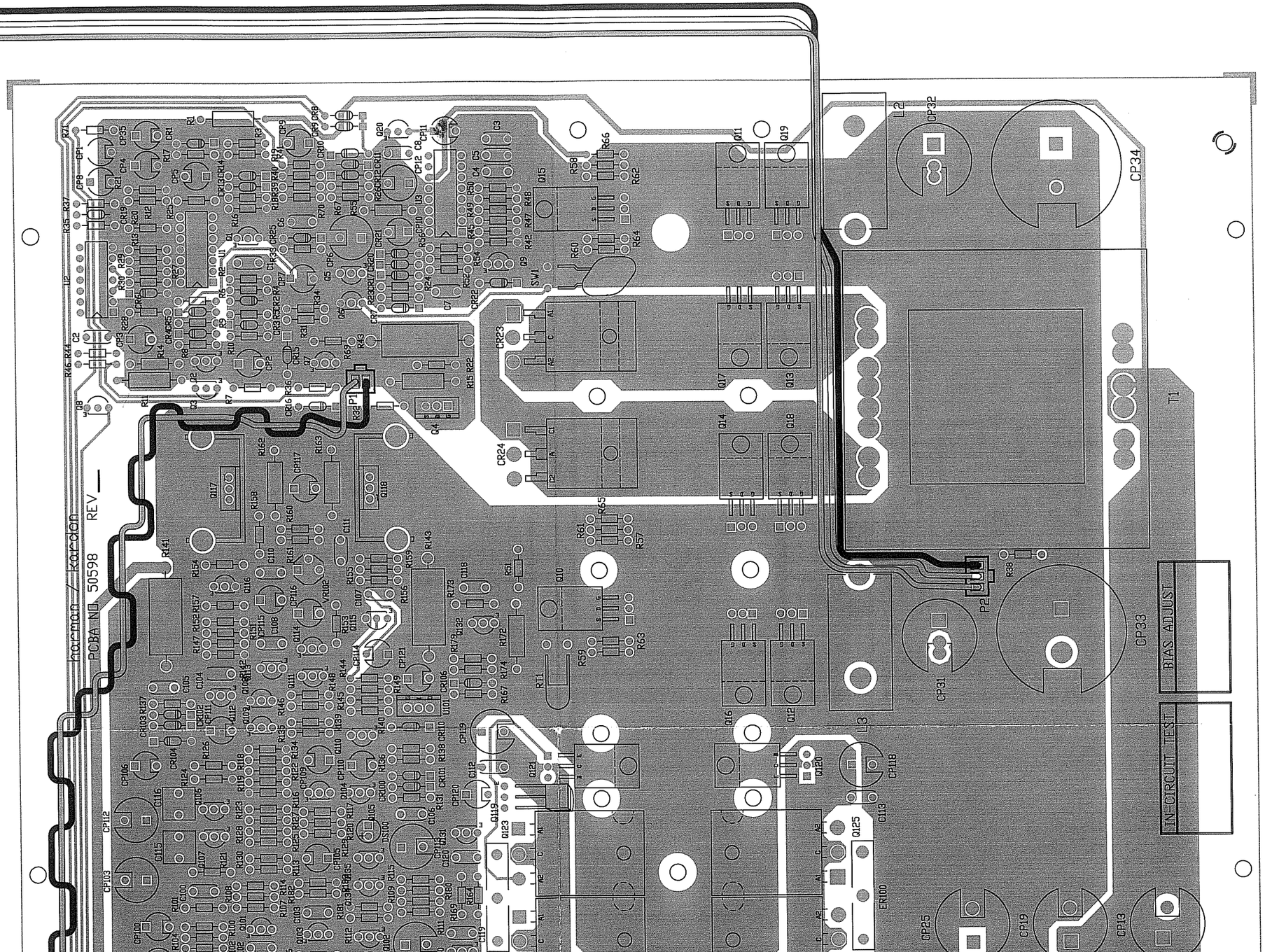


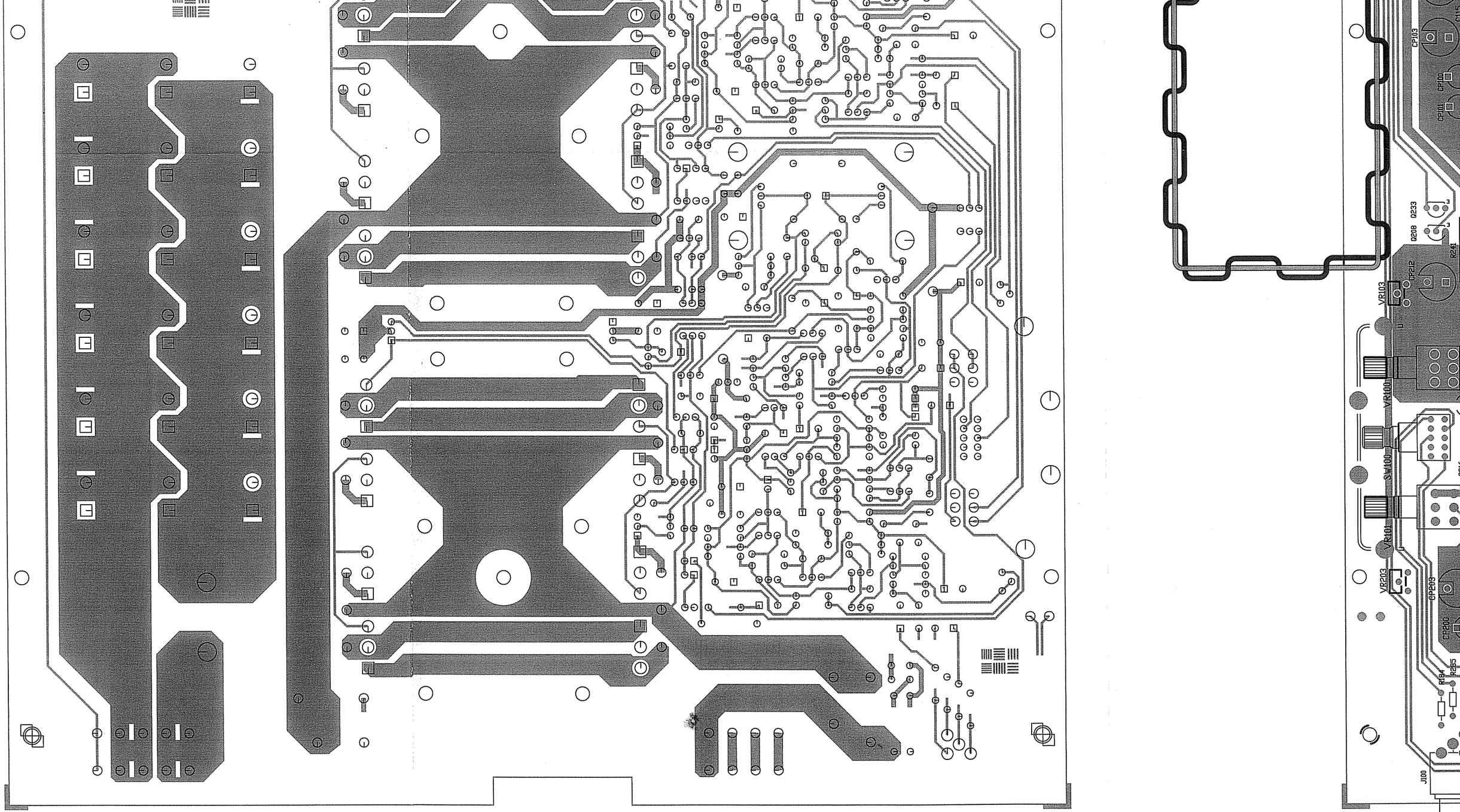


LED Assembly
ref. #125
part #51889-001

Fan Assembly
ref. #120
part #50617

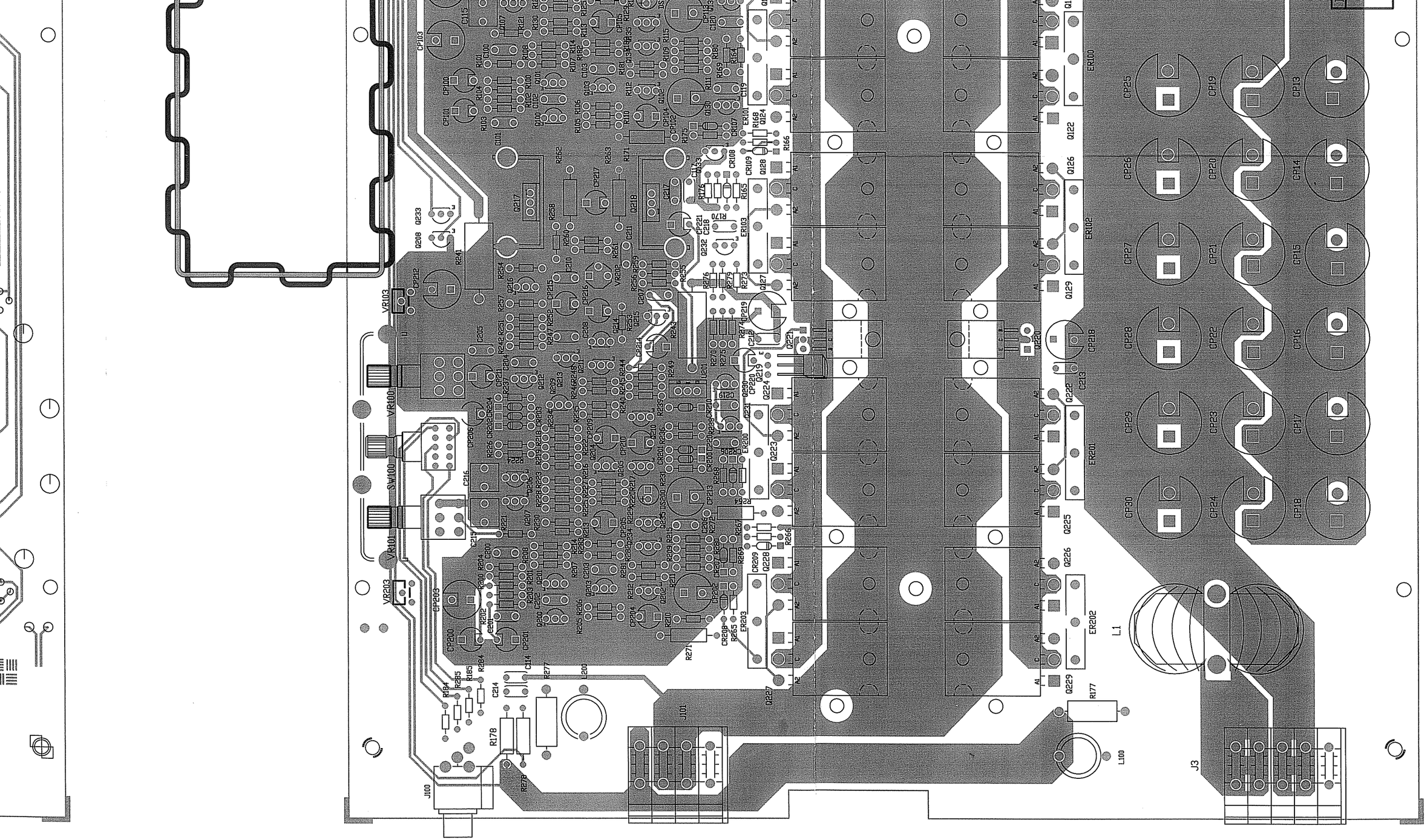






BOARD AS VIEWED FROM SOLDER SIDE

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q



BOARD AS VIEWED FROM COMPONENTS SIDE